Livestock Policy

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Qilian Mountains, Gansu Province, China: Tibetan Plateau biome

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INTRODUCTION

China has four million square kilometers of rangeland, occupying 42% of the total land area (MOA, 2010), where live about 17 million agroherders and herders (ECOCAHYB, 2011). The land comprises 268 semipastoral and pastoral counties, mainly located in the provinces of Inner Mongolia, Tibet, Qinghai, Xinjiang, Gansu, Ningxia, Heilongjiang, Yunnan, Jilin, Liaoning, Sichuan, Hebei and Shanxi (MOA, 2013). Most of those areas are the traditional home of ethnic minorities, whose livelihoods and lifestyles revolve around herding and livestock (Long et al., 2008). As in many parts of the world, the rangeland in China fills essential ecological functions that affect both regional and global ecosystem processes. Although only a limited proportion of the national livestock production comes from pastoral areas (mutton 17%, beef 9%, cashmere 33%, wool 24%) (ECOCAHYB, 2011), animal husbandry is the primary livelihood source for local herders (MOA, 2011a).

Policies have played a major role in shaping rangeland management. Before the 1950s temples, monks, nomads, or tribes privately owned almost all the rangelands. People respected and depended on their rangelands, which ensured their livelihoods. They relied on the fact that the livestock depended on the forage from the rangeland, and humans depended on the livestock and the rangeland. The rangeland is at the basis of the livestock husbandry system, and this system was stable before collectivization but economic returns were low (Brown et al., 2008; Squires et al., 2009). After the 1950s, collectivization changed this notion and again de-collectivization promoted further change. In the 1980s, the introduction of rural reforms, notably the Household Contract Responsibility System (HCRS), led to economic benefits but accelerated to some extent rangeland environmental degradation in some regions (Banks, 2001; Han et al., 2008). HCRS policies promoted sustainable use and management of natural resources, especially in crop and grassland (cultivated pasture) areas, and consequently tried to achieve the two goals of alleviation

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of poverty and conservation of natural resources; they were enacted in the Grassland Law of China in 1985.

A few years ago, the government introduced HCRS in pastoral areas across China. Since 2000, the Chinese central government has paid closer attention to protecting rangeland areas and other ecosystems, because rangeland degradation has been accused of severe climatic events, such as sand storms, high mortality floods, and downstream impacts, especially those related to water for irrigated crops, human urban consumption and industrial use. In other words, rangeland degradation in Chinese pastoral areas impacts the Chinese agriculture, urban centers and industry. According to Wu and Richards (1999), there has been considerable variation in the way the national policy was implemented by Chinese local governments.

The main policies regarding rangelands and the lives of breeders have succeeded one another starting in the middle of the 1950s, just after the Chinese Revolution of 1949, until the middle of the 1960s, just before the Cultural Revolution, then from the end of the Cultural Revolution during the second half of the 1970s to the beginning of the 21st century, and over the last two decades. In all three periods, the central government policies strongly influenced the livestock systems in the rangeland areas, as well as in grasslands.

POLICIES INITIATED BETWEEN 1953 AND 1963

With the founding of new China in 1949, all land was to be communally managed and owned. In the 1950s, the first policy to address rangeland problems was developed. This was the "General Summation of the Pastoral Production in Pastoral Areas in Inner Mongolia, Sichuan, Qinghai and Xinjiang Provinces." These provinces form the vast areas of rangelands in Northern and Western China. This policy had an important impact on rangeland management as it stipulated that the production of livestock on pasture land should be increased, and institutions should be developed to promote higher yields. The policy also aimed to replace crops with livestock production in marginal semiarid zones. Changing pastures to crop production was prohibited. The impact of this policy was limited because it was replaced by two new ones. The policy for a "National Program for Agricultural Development" in 1958 prioritized pastoral development. Again, the policy favored livestock breeding on rangelands and promoted conservation of pasture resources. It was recognized that the need to grow high-quality grasslands called for the provision of additional water points for livestock. This policy has led to more institutions promoting productivity and technological improvements on rangelands through research and outreach. However, the development of additional water points has increased local overgrazing in many zones (Banks, 2001; Williams, 2002). The "Regulations on Policies for the Minority Ethnic Groups and People's Communes in Pastoral Areas" were enacted in 1963. The policy recognized that rangelands needed to be protected by maintaining water resources, killing rodents, and building water conservation

works. Instead of private investments, the central government began funding these activities. This was a radical shift in resourcing rangeland development. Because of these three polices, livestock numbers doubled in many areas (Longworth and Williamson, 1993; Huang, 1996). From 1966 to 1978, the Cultural Revolution interrupted more than a decade of policymaking, which resumed in the mid-1970s and intensified.

POLICIES INITIATED BETWEEN 1978 AND 2002, AND ONWARD

In 1978, China began rural reforms, and farmers, including the poor, benefited from steady income growth and increased food security. During the planned economy period in 1976, the per capita annual income of the national people's communes (agricultural collectives) was 60.2 yuan (¥), lower than that in 1956 at constant prices. At the time, more than a third of farmers were heavily in debt and about 100 million farmers faced food shortages. By 1978, China was no longer self-sufficient in grain and had to rely on imports to feed 40% of the urban population. In 1978, farmers set up the collective contract responsibility system for production, which was developed into the household contract responsibility system in 1981. The enthusiasm of the peasants received a positive response from the senior leaders, and eventually led to the abolition of the people's commune. The reform program implemented in the 1980s included the following measures:

- Family farms replaced collective farms. Small farms run by farmers have an average of 0.5 hectare of land use rights;
- Abolish the state monopoly on the purchase and sale of agricultural products, open the free market, implement the state contract purchase system, raise prices and change price and market policies;
- Develop structural policies to promote agricultural diversification. The formulation of rural non-agricultural economic development policy is to employ the surplus labor in non-agricultural activities.

The above measures were issued each year from 1982 to 1986 through the document of the CPC Central Committee, the top priority in decision-making by senior leaders. Firstly, Document 1 played a role in getting local governments to pay attention to food production and rural development. Secondly, it promoted measures to achieve the short-term objectives of the current year's policies referred to in the document. Thirdly, it reiterated medium- and long-term strategies and policies for food security and rural development.

For the period 2004–2013, Document 1 focused on the following issues:

- According to market signals, the minimum price guarantee system for rice and wheat growers should be established to protect farmers from price fluctuations. When the market price is higher than the guaranteed price offered by public

procurement agencies, farmers can sell their products to any other buyer. The minimum purchasing prices for public procurement have steadily increased. For example, the price of first-grade paddy rice was 1.64 ¥/kg (~0.27 US$) in 2008, whereas it was 3.0 ¥/kg (~0.5 US$) in 2013, and the price of first-grade wheat was 5% lower than that of paddy rice in the same period;

- Subsidies are offered to grain growers, payments are made directly to the planting areas, for high quality seeds (and animal breeds), agricultural inputs and tools, and machinery， such as diesel and chemical fertilizers;
- Increase public investment in infrastructure improvement and agricultural research. For example, in 2011, the central government spent 130.99 billion ¥ (21.1 billion US$) on building irrigation facilities, rural roads and power;
- Expand key demonstration zones for agricultural technology extension. In addition to providing extension services, mechanization of small farms is promoted by the production of small machines and tractors. This is to drive the rich farmers to specialize in machine service and enter the agricultural service market. The modernization of small-scale agriculture has led to a dramatic increase in grain yield, from three tons per hectare in 1984 to 4.88 tons per hectare in 2008;
- More investment is assigned to capacity building for disaster mitigation and prevention, as well as to land amelioration and consolidation. Fiscal spending of central government on these items amounted to 104.2 billion ¥, equivalent to 16.8 billion US$, in 2011;
- The agricultural growth of 1978–1985, together with the acceleration of industrialization and urbanization since the 1990s have enabled most rural households to achieve food security and escape from poverty. Table 1 shows that the average commercialized rate of grain output per household increased with the gradual decrease of cultivated land area. As the share of non-farm labor rose, the share of farm income as a share of total household income declined. Firstly, such a trend reflects the shift from part of agricultural land to non-agricultural use. Secondly, agricultural productivity was enhanced. Thirdly, about 260 million rural workers migrated to cities each year and provided substantial financial support to their families in their home villages or towns every year.

With the advance of the rural reform process, the central government implemented the poverty alleviation plan in 1982 in a few Western provinces, and launched the national poverty alleviation strategy in 1986, aiming to solve the problem of food and clothing for the poor by promoting the development of poor areas. By 1994, the goal of food security was achieved. Subsequent antipoverty schemes chiefly aimed at eliminating income poverty. Among the major anti-poverty measures to date, socioeconomic and human resource development projects have been implemented. According to the poverty line set by the World Bank (US$ 1.25/day/capita consumption or income), the incidence of urban poverty in China dropped from 44.5% in 1981 to 0.9% in 2008, and the incidence of rural poverty dropped from 94.2%

to 22.3% in the same period. In 1978, China began the rural reform and identified 250 million rural poor. It is measured in terms of the poverty line, which is defined as 200 kilograms of food per person per year.

Table 1: Household income and off-farm activities

Year	Household size (person)	Family labor (person)	Non-agricultural labor (%)	Cultivated area (mu*)	Sold quantity / total grain output (%)	Annual net income / capita (¥)	Farming Income (%)
2000	4.2	2.8	29.7	7.43	44.8	2253	46.2
2005	4.1	2.8	37.9	7.09	59.0	3255	42.4
2008	4.0	2.8	41.0	6.86	63.9	4761	38.3
2010	3.95	2.85	ND	6.50	ND	5919	ND

15 mu = 1 ha; 1 US$ = 6-7 ¥ to 8-9 ¥ depending on the period; ND: no data available
Source: Ministry of Agriculture, China, 2009 and 2012, China Agricultural Development Report, Beijing, China Agriculture Press

Public support has greatly strengthened food supply and food production has been increasing. The total grain output exceeded 400 million tons in 1984 and 500 million tons in 2010. Edible oil production exceeded 16 million tons in 1990 and doubled in 2010. Meat production of 29 million tons in 1990 increased by 189% in 2012.

The first major policy emerged from the United Nations Rio Conference on Sustainable Development in Rio de Janeiro and led to Agenda 21 that spelled out China's priorities and environmental goals. At the same time and since 1978, the Chinese rural economy has undergone three major reforms. The first was the introduction of HCRS. Because of its importance to pasture development in the 1980s, it is evaluated separately further on. The second one was the proliferation of "Town and Village Enterprises" throughout the 1980s. The third one was the "Tidal Wav" of the Chinese rural economy and began in 1995. It embodied the concept of agro-industrialization (*nongyechanyehua*) but it was preceded by other measures that were gradually introduced from 1979 (Brown et al., 2008).

In 1979, the policy "Resolution on Several Problems Related to the Speeding up of Agricultural Development", aiming at solving problems regarding agricultural development and improving pasture management, was introduced. This policy was similar to that of 1959 and focused on building water conservancy facilities, fostering rotational grazing, improving livestock breeds, and increasing the carrying capacity. This resolution also issued contracts to families to use rangelands for their livestock. By 1982, the household contract problem had become a top priority. The government extended HCRS to the whole of China. This significant policy clarified regulations for expounding grazing land agreements to households in rangelands and families were given safeguards, such as lands given for livestock to graze. This transfer from public use to family use had a deep effect on the people and the status of grazing lands.

Since 1978, because of the contracts issued, the successive Chinese governments had become aware of rangeland degradation and the importance of developing environmental policies for rangeland protection. Thus in 1984, the policy "Instructions on the Campaign of Making the Countryside Green" was issued and included more severe punishment clauses for degrading forests or rangelands. This policy resulted in reducing landscape degradation. To reinforce the measures to protect against land degradation, land tenure included, the "1985 Grassland Law" was also issued. Among others, the policy authorized local governments to fine people who degraded rangelands or to condemn them to restore them. To enforce the "1985 Grassland Law", several departments were created within the Animal Husbandry Bureau of the Central Government. The local sector was developed with the aim to alleviate poverty with an emphasis on sustainable management of natural resources; in particular upstream of Yellow River and Yangtze River, plans included improving infrastructures and empowering local institutions to address social vulnerabilities and protect rangelands (Liu et al., 2001). Since the mid-1990s, a national development strategy has emerged through the "Great West Development Program", which lays the framework for sustainable development.

In 1998, the "Natural Forest Protection Program" was implemented to prohibit logging in natural areas (~30 million ha) upstream of the Yangtze River and upstream and middle stream of the Yellow River. The central government provided financial aid and granted tax reductions so that local governments could assist workers who had lost their jobs after the shutdown of timber enterprises, and help new businesses get started (CCICED, 2002). The "Conversion of Cropland to Forest and Grasslands Program" (CCFGP), also known as "Grain for Green", was implemented starting in 1999. Thus, 6.07 million hectares on steep slopes qualified for the program, among which 70% was located in Yangtze River and Yellow River areas. In all, about 17.8 million hectares, i.e. 52% of Western China cropland area was concerned by the program (CCICED, 2002).

CCFGP main goals were to alleviate poverty while preserving water and lands. Supported by many government agencies it aimed at converting steep slopes from crop production to forests and pastures and thus contribute to helping millions of land users while preserving the environment.

In the mid-1980s, HCRS initially concerned the main grazing zones, it has however extended today to the main pastoral provinces of Northwestern China. "By 2011, the total contracted rangeland areas accounted for 79% of China's usable" rangeland (MOA, 2011b). According to HCRS rangeland degradation is caused by overgrazing of these open-access areas. The policy aimed thus at defining household's property rights, i.e. the carrying capacity of the grazing land should equal or exceed the number of livestock there. This approach was assumed to prevent further rangeland degradation, even restore it. "By 2011, grazing had been excluded from 40.33 million hectares of rangeland in the main pastoral areas, representing about 15% of useable grassland in these areas being taken out of use" (MOA, 2011b). As these

measures had a major impact on local herders, the government granted them subsidies so that they could either give up open-range livestock breeding or develop intensive livestock farming.

POLICIES INITIATED BETWEEN 2006 UNTIL NOW

The "1985 Grassland Law" was amended to develop further the measures related to rangeland protection, and its new version was implemented in March 2003. Figure 2 sketches the livestock policies set up in Chinese rangelands since 1949. Originally, the policy focused on increasing livestock production on farms but after the Cultural Revolution, there was a strong demand for user rights. However, to confer these rights caused many land use problems, especially with the increased public awareness of environmental degradation along with economic consequences in China (World Bank 2001). These have led to further policies to reduce flooding and adapt to climate change. As shown in Figure 2, the local government of Qilian Mountains included the regulations of the provincial and county governments when implementing these policies.

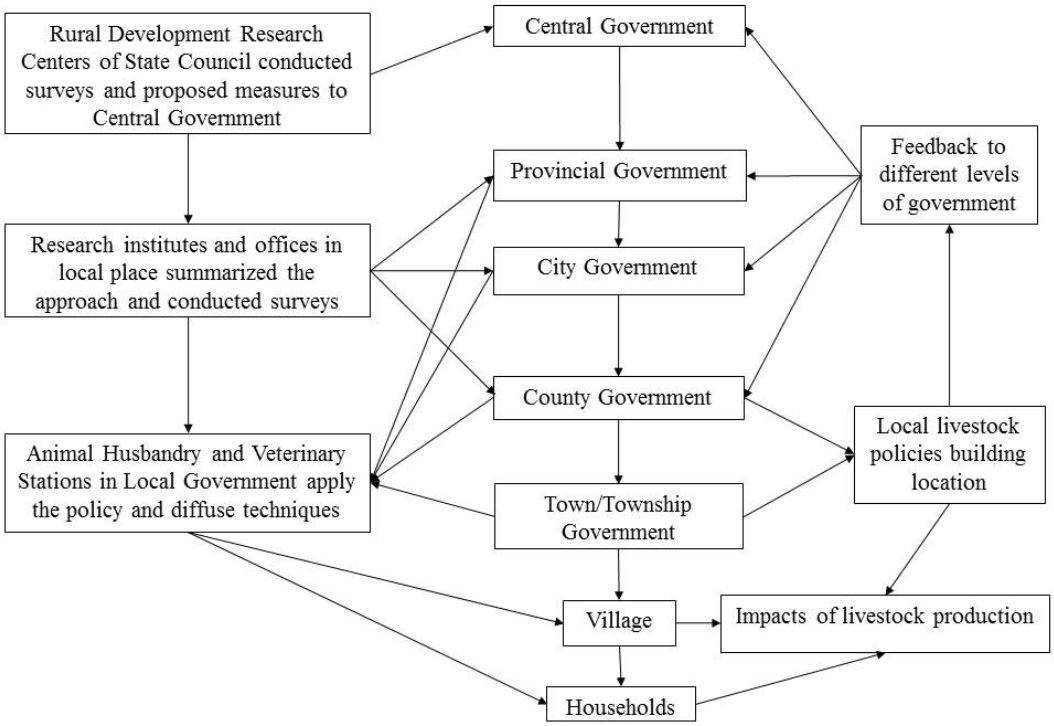

Figure 2: Flow chart of the top-down livestock policy development in the rangeland areas of China

EFFECTS OF POLICIES ON LIVESTOCK FARMING IN QILIAN MOUNTAINS

The Chinese Revolution then the Cultural Revolution implemented very constraining policies on the land then on herds, which destroyed the traditional complex rules set up by the monks, temples, tribes, or breeders, with severe consequences, especially in terms of pasture degradation and water depletion. After terrible crises, public policies have been progressively implemented, especially HCRS, in order to reduce or limit the environmental impacts of livestock activity in the rangeland. They mainly focused on the pasture, as a source of feed, and on the herd.

Effects of public policy on the pasture

Regarding the use of the pastoral resource over the past three decades in Qilian Mountains, the main public policy effect, and above all that of HCRS, is the presence of fences on pastures (Long et al., 2018). Fences on rangelands indicate the right to use the land, not the right to own it, by the family to which it has been assigned, as it remains a community good: the community is always the landowner and the diverse families of the community receive pieces of land to develop their rural activities. For these authors, "The concept of usage right seems to be evolving. Indeed, it means that not only can the family graze its herds on the allocated land, but it can also rent it out and earn income from it – or even rent additional land from others if required." They add: "Usage rights can be transmitted from the parents to the children under certain conditions, but it seems more advantageous for the families that the young couple settling down asks the community for its own and separate usage rights to land" (Long et al., 2018).

Furthermore, the new rule on the use of fences in the rangeland has been often adopted without considering the local topography, and the use of water and roads. Under certain conditions, this can lead to harsh conflicts between families. In addition, these dividing lines were established about 30 to 40 years ago, when families varied in number. Today, the situation generates problems, e.g. during the transmission process of usage rights.

The grant of land-use rights applies not only to pastures but also to grass plots used for the production of supplementary feed for herds in winter and spring, especially during calving, lambing and kidding. However, there are differences between villages according to the ethnic populations, the available surface of winter plots, feed demand, etc., so that it is relatively fairly attributed while remaining flexible. Long et al. (2018) also observed that "the putting up or the repair of fences provides an opportunity for mutual assistance between households, especially since households in the same family often have adjoining usage rights on the same mountain pastures." These authors add: "Collective forms of pastoral resource management still exist within the extended family, between parents and children, between brothers and between cousins, and between neighbors." For example, when a family member or the whole household has to take leave, or in the case of dual activity, family

or neighbors take over the care of their mountain pasture and village plots. Specific arrangements exist at village scale. This solidarity is also reflected in the reciprocal relationship of winter forage fields when they are plowed when necessary or rented at preferential prices.

Long et al. (2018) noted that "surface areas allocated vary according to a number of factors, including locality, year of allocation, and household size." In other words, within the same zone or between two counties there may be differences between the surface areas allocated. Furthermore, Long et al. (2018) wrote: "a difference in rainfall exists with about 600–800 mm in Huang Cheng, and only around 500 mm in Tianzhu. In addition, the rangeland's productivity depends on the orientation, the altitude, whether and how much it slopes and, of course, the practices implemented, in particular the respect of recovery periods." The allocated surfaces for winter forage are around one and two hectares per household, according to the village, the county and above all the available area. These areas are usually located in the valleys, close to villages where the herds stay during cold months.

Long et al. (2018) reported that "rental of forage plots is common. It allows large herds to obtain the feed they need and, at the same time, the owners of smaller herds can earn an additional income." The rental income is around 10 ¥/mu (~20 €/ha) for summer and autumn rangelands, and around 25 ¥/mu (~45 €/ha) for winter rangelands and forage plots. It is a significant income, especially for older farmers as it brings them a supplementary revenue.

In conclusion regarding the public policy effects, HCRS has considerably changed the rangeland context, especially through the land use allocated to the households. HCRS became the rule but the norms can be adapted at local scale, especially at village level according to the available grazing and winter forage areas, the number of households, the climatic conditions, the specific demands, etc. These norms are defined both by the local administration and the leaders of the community and consequently there are accepted and respected by the households.

Public policy effect on herds

The public policy effect on herds is a bit different from that on pastures, even though the two are linked. To understand this, key information on herds is necessary. A typical breeder family has two herds, one consisting of 30–40 yaks and the other of 100 sheep, frequently with some goats. Breeding bigger herds, e.g. 100 yaks and/or 200–300 sheep, requires extra labor. Rangeland breeders are generally from minorities and are not limited to one child per couple. Children go to school but they help during weekends and holidays, especially for the transhumance. However, the main part of the work is carried out by the couple, eventually with one or two grandparents.

Among the constraints that face the herders, yaks are milked in the morning, and, as anywhere else on the planet, milking takes place every day all year round. Yaks

often eat grass also in the evening. There may be goats present in some farms that also need to be milked. Newborn calves, heifers and bulls require attention. Sheep have to spend the night in barns or corrals to save them from predators such as wolves and foxes. Inspection and eventually care are carried out in the morning before going to the pasture, or in the afternoon when the herd comes back. During grazing time the shepherd identifies animals requiring special care. According to Long et al. (2018) "the rest of the time available is devoted to other activities directly related to animal husbandry, such as the stocking up of feed for the winter, or the sale or purchase of livestock or inputs, and to more general farm activities such as maintenance of equipment, upkeep of buildings, shopping for the family, etc."

Transhumance usually begins in late May to mid-June, when the summer pastures have begun to grow. The highest pastures are at an altitude of 3500–4000 meters, at the limit below the rocky parts. They are usually located dozens of kilometers away from the villages. The transhumance departure is decided collectively at village level depending on weather conditions, and the quality and quantity of pastures in the alpine meadows.

Most of the family income (60–70%) comes from the sales of animals (Long et al., 2018). A secondary income may come from other products such as wool, leather, milk, cow dung for heating. The yak bulls are sold 4000–6000 ¥ (450–700 €) at 4-5 years old, according to the size, weight and fat cover, at a live weight of 200–250 kg. Cull yak cows are sold 2000–3000 ¥ (250–350 €) depending on the weight and fat cover, at the end of their reproductive career, usually at 12 to 18 years. The lambs are sold at six months old 450–600 ¥ (55–75 €) according to their size and live weight (15–17 kg) in June-July, just before or at the beginning of the transhumance. Long et al. (2018) noted "a few variations in sale conditions and prices depending on the breed and the practices of breeding and feeding."

Regarding the production, there are about 100 sheep in a flock that produce around 95–100 lambs per year (~one lamb/ewe/year). Around 20 female lambs are retained for the herd and 75–80 lambs are sold. In a herd of approximately 50 yaks, there are 12–15 cows that calve and about as many heifers. About 4–6 yaks are sold each year. Female yaks produce one calf every two years, or two calves every three years, depending on the breeding conditions, especially the quantity and quality of feed. According to Long et al. (2018), smaller intervals have been reported. The age at first calving is 5-6 years old.

A farm breeding 40 yaks and 80 sheep annually sells for about 40,000–45,000 ¥ (~5,000 €) of meat animals. The income from wool increases by 5–10% with Tibetan sheep, 15% with Merino sheep, and 20–25% with White yaks whose tail is also valuable. A Merino sheep produces 3–4 kg of wool yearly which is sold 25–35 ¥/kg (3–4 €/kg). Leather is sold to the butchers at 80–100 ¥ (10–12 €) per skin.

According to Long et al. (2018) different subsidies and allowances per head of livestock are received by families, especially through HCRS. Household incomes thus

increase by about 10%, regardless of other subsidies such as those to buy tents and other equipment for transhumance, or to repair farms or build new ones that will be better adapted to the harsh winters, or to buy apartments in the city for near-retirement farmers.

Additional activities exist to increase the farm income, for example entertaining visitors in tents and offering them a traditional meal or *Cordyceps* harvest (*Ophiocordyceps sinensis*). Other activities, particularly those related to trade and services, cause longer periods away from the farm. In those cases, the remaining family members rely on parents, siblings, or neighboring farmers to lessen the labor burden.

The main cost of a herd is the feed (including sometimes concentrates), and grassland rental. The building of stables and sheep pens had been a major investment but the decline in mortality and increase in livestock weight seemed to have balanced out the expense, especially since these facilities had been largely subsidized.

CONCLUDING REMARKS

Since 1953, about 10 major policies have been enacted to benefit rangelands and those who live off them. In Qilian Mountains, over the past 60–70 years, herders have gone through three stages. The first stage began in 1949 with the Chinese revolution and continued until the Cultural Revolution in the mid-1970s. Both revolutions have completely changed the traditional land structure, which was until then owned by monks, nomads or tribes and where sustainable pasture management prevailed. The second stage began in the 1980s with large-scale public action, organized around HCRS, which aimed at improving the living conditions of families while seeking to reduce pasture degradation. In the third and current phase that began in the early 2000s, the high local demand for livestock products has further emphasized the positive impact of HCRS on livestock breeding. The successive policies over the last half century have clearly impacted livestock in Qilian Mountains, and more generally in Chinese rangeland areas.

Progressively the livestock sector has become highly dependent on the policy focused on animal and pasture, but also on environmental and social issues. However, no action has been taken to date toward sustainable pasture management. Instead, the pressure on the land has been increasing because of the increasing herd size. Significant efforts have to be made to reverse the situation and improve the sustainability of livestock in the rangelands. In addition, many young people give up livestock breeding to find jobs in the cities. This is a problem but also an opportunity for rural populations to move on to more social sustainable practices where animal husbandry is redefined, especially since public authorities have committed their support.

The herdsmen in Qilian Mountains have overcome drastic changes but without redesigning their management of pasture resources. Nevertheless, the ongoing social

changes, particularly the lack of interest among young people for animal husbandry, might be offset by the access to new social and technological alternatives provided by the New Information and Communication Technologies and pave the way to greater sustainable opportunities.

References

Banks, T. 2001. Property rights and environment in pastoral China: evidence from the field. *Dev. Change*, **32**: 717-740

Brown, C., Waldron, S., Longworth, J. 2008. Sustainable development in Western China: Managing people, livestock and grassland in pastoral areas. Edward Elgar Publishing, Cheltenham

CCICED, 2002. Summary on implementation of China Council for International Cooperation on Environment and Development Recommendations. Phase III, 2002-07. www.harbour.sfy.ca/dlam/history/html

ECOCAHYB (Editonal Committee of Chinese Animal Husbandry Year Book [ZhongGuoXuMuYeNianJianBianZhuanWeiYuanHui]), 2011. Chinese animal husbandry. Chinese Agricultural Publish, Beijing

Han, J.G., Zhang, Y.J., Wang, C.J., Bai, W.M., Wang, Y.R., Han, G.D., Li, L.H. 2008. Rangeland degradation and restoration management in China. *Rangeland J.*: 233-239

Huang, Y. 1996. Inflation and Investment controls in China. The political economy of central-local relations during the reform era. Cambridge University Press, Cambridge, UK

Liu, Y., Baas, S., Ni, H. 2001. Strengthening pastoral institution in North-West China pastoral area to access improved extension services for risk management and poverty alleviation. FAO – MOA/CIAD

Long, R.J., Ding, L.M., Shang, Z.H., Guo, X.H. 2008.The yak grazing system on the Qinghai-Tibetan plateau and its status. *Rangeland J.*, **30**: 241-246, doi: 10.1071/RJ08012

Long R., Qi X.J., Ding L., Yang T., Bonaudo T., Hubert B., Tourrand J.F. 2018. On the roof of the world, the herders of the Tibetan plateau confronted by change. In: Bosc P.M. et al. (eds.). Diversity of family farming around the World. Existence, transformations and possible futures of family farms. Springer, 15-25

Longworth, J.W., Williamson, G.J. 1993. China's pastoral region: sheep and wool, minority nationalities, rangeland degradation and sustainable development. CABI International, Oxford, UK, 368 p.

MOA, 2010, 2011a, 2011b, 2013. China national grassland monitoring report. www.grassland.gov.cn/Grassland-new/Category_11/Index.aspx (accessed 2013-5-16)

Squires, V., Lu, X., Lu, Q., Wang, T., Yang, Y. 2009. Rangeland degradation and recovery in China's pastoral lands. In: Squires, V. (ed.) Rangeland stewardship in Central Asia: Balancing improved livelihoods, biodiversity conservation and land protection, CABI, Oxford, UK, 219-234

Williams, D.M. 2002. Beyond great walls: environmental, identity and development on the Chinese grassland of Inner Mongolia. Stanford University Press, Stanford, USA

World Bank, 2001. China – air, land and water: environment priorities for a New Millennium. World Bank, Washington, USA, 149 p.

Wu, N., Richards, C. 1999. The privatization process of rangeland and its impacts on the pastoral dynamics in the Hindu-Kush Himalayas: the case of western Sichuan, China. In: People and rangelands: building the future, Proc. 6th Intl Rangeland Congr., Townsville, Qld. (Eds D. Eldridge, D. Freudenberger), 14-21